Space Weather Technical Forecast

Issued on Saturday, 03 September 2022 at 13:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares (R1-R2 Blackouts). G1/G2 Minor/Moderate Geomagnetic Storm expected day 1 or 2 (3rd/4th Sep).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low but with frequent C-class flares. Of the four active regions on the visible disc, AR3089 remains the largest and most complex region. This region continues to grow in areal extent and complexity, now with a delta configuration. The other 3 sunspots in the east are all relatively simple.

A marked filament eruption was observed leaving the sun on 02 Sept. The CME that followed is modelled to have been passing mostly behind and below the Earth, though there is a chance of a glancing blow on 05 Sept (day 3). No other Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, suggests the arrival of a coronal hole high speed stream. The solar wind speed was initially fairly steady at slightly elevated levels before showing an erratic rising trend during the early hours of 3rd AM UTC, becoming mostly elevated from 03/0900 UTC. The density was average to start, rose to above average through the period, reaching 30ppcc by 03/0500 UTC then fell back to average. Total interplanetary magnetic field strength (IMF Bt) was largely weak before increasing to moderate between 03/0500-1000 UTC reaching 12nT, the fell back to weak. The north-south component, Bz, showed a similar trend, with fluctuations between +10/-9nT during 03 AM UTC. The Phi angle also fluctuated between negative an positive during the period especially between 03/0000-0600 UTC before settling at positive (away from the sun), likely indicating the SSBC and subsequent connection to a high speed stream, probably that of CH19/+. Geomagnetic activity was initially Quiet, became Active with two G1/Minor storm periods at 03/0000-0300 UTC and 03/0600-0900 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV), as measured at GEOS-16 was at background levels. The high energy electron flux (greater than 2 MeV) remained at background to moderate levels. The 24-hour integrated electron fluence remained well below the Active threshold (1e8 integrated pfu), with 3.11e6 integrated pfu observed at 03/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain largely Low, with an ongoing chance of Moderate flares at times, mostly from AR3089. However, a new region may rotate onto the northeast limb on 05 Sept (day 3), potentially increasing the probabilities of a significant flare.

Solar Wind / Geomagnetic Activity: The CME that left the sun on 02 Sept may give Earth a glance on 05 Sept. No other Earth-directed CMEs expected otherwise. Solar winds are expected to remain generally elevated from now until 06 Sept (day 4), under the successive coronal hole influences of CH19/+ immediately followed by CH20/+. Wind speeds are then expected to fall back to slightly elevated or background from early on 06 Sept (day 4) onward. Geomagnetic activity is therefore expected to be Unsettled to Active from the outset with further G1/G2

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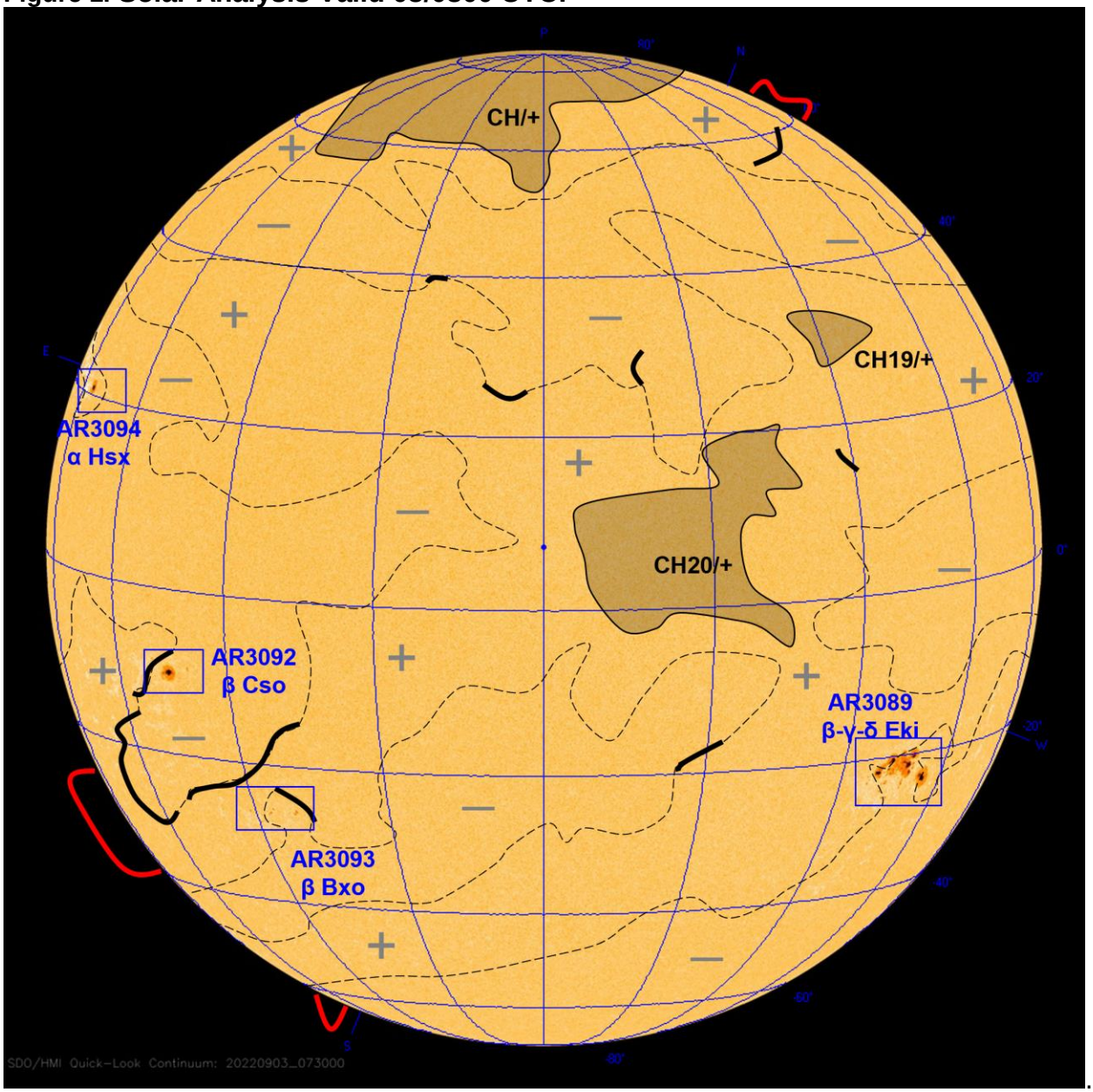
Minor/Moderate storm intervals between 03 Sept and 05 Sept (days 1-3), due to coronal hole and CME influences. Geomagnetic activity is then expected to slowly return to Quiet or Unsettled from 06 Sept (day 4).

Energetic Particles / Solar Radiation: High energy protons (greater than 10 MeV) are expected to remain below S1/Minor radiation storm levels. The high energy (greater than 2 MeV) electron flux is expected to be at background levels initially but to increase over the following days, with an increasing chance of exceeding high levels. The corresponding 24 hour fluence is expected to display a sharp rising trend from 04 Sept (day 2) onward, with a chance of exceeding the Active threshold on 06 Sept (day 4).

Figure 1. Solar Analysis Valid 03/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A marked filament eruption was observed leaving the sun on 02 Sept. The CME that followed may give a glancing blow at Earth on the 05 Sept (day 3), however confidence is low regarding this. ENLIL suggests only a slight perturbation in the already elevated wind speeds on 05 Sept, this is considered to be good guidance with little overall impact at Earth.

Solar winds are currently elevated due to the theorised official arrival of the SSBC and CH19/+ during the early hours of 03 Sept UTC. Wind speeds are expected to remain generally elevated from now until 06 Sept (day 4), under the successive coronal hole influences of CH19/+, perhaps almost seamlessly followed by CH20/+. There may be periods where wind speeds dip below elevated due to the complexity of CH20/+. Wind speeds are expected to fall back to slightly elevated or background levels from early on 06 Sept (day 4) onward as we exit the HSS of CH20/+. ENLIL is seemingly giving good guidance for the arrival of HSS's and their associated wind speeds, though ENLIL is keeping the elevated wind speeds almost until the end of the period. This is considered to be much less likely.

Geomagnetic activity is therefore expected to be Unsettled to Active from the outset with further G1/G2 Minor/Moderate storm intervals between 03 Sept and 05 Sept (days 1-3), due to coronal hole and CME influences. The greatest risk of this is expected to be on 04 Sept when Earth connects to CH20/+, as this is the more mature feature on the solar disk. Geomagnetic activity is then expected to slowly return to Quiet or Unsettled from 06 Sept (day 4).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	70	80	50	5
Strong	G3	No	5	10	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
03/0742	NIL	Filament eruption	SE	750	05/1200 UTC	Glancing blow, limited effect.

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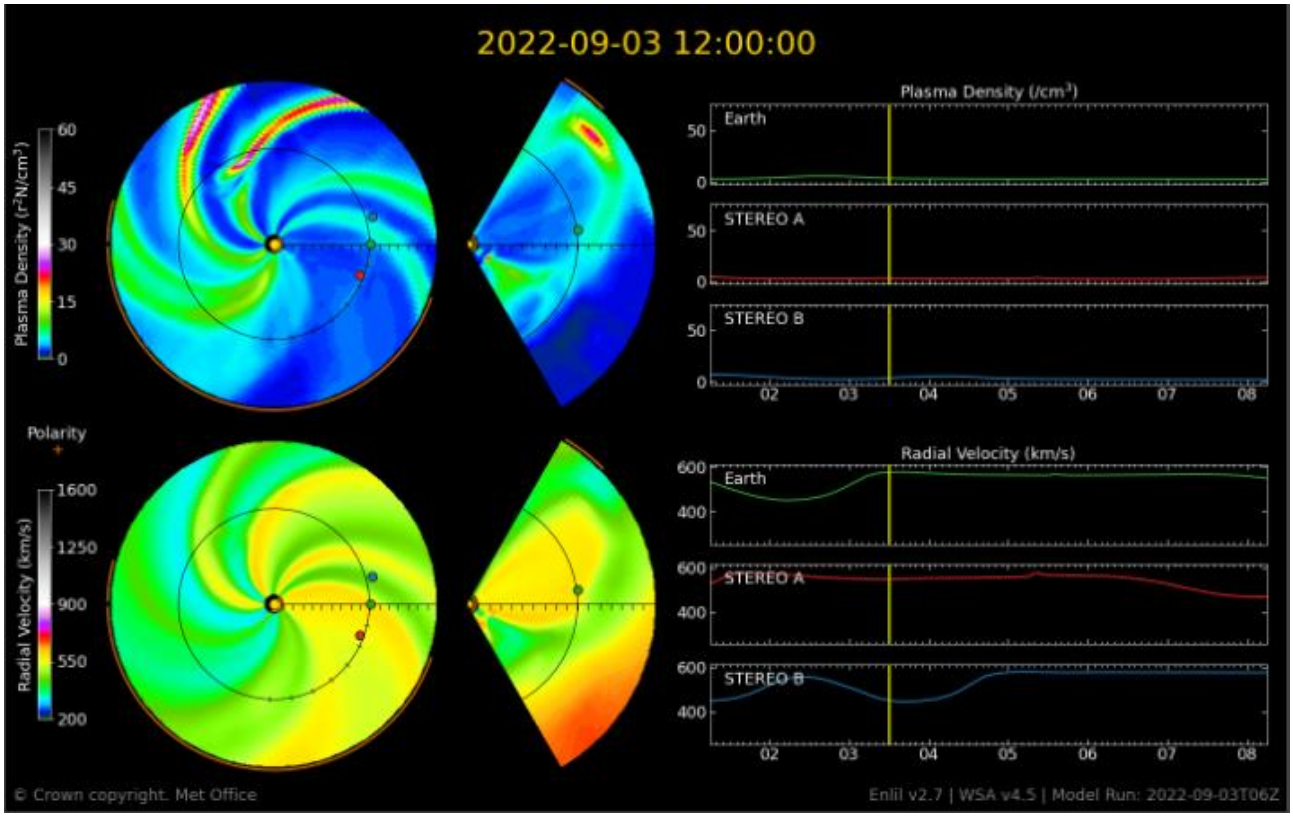
Figure 2: ENLIL showing HSS arrival today and poss glancing blow on 05th from CME from 2nd



Radio Blackouts - X-Ray Flares:

Solar activity has been Low but with frequent C-class flares. Of the four active regions on the visible disc, AR3089 remains the largest and most complex region. This region continues to grow in areal extent and complexity, now with a delta configuration. This spot is expected to contribute to the risk of flares until 7th Sept when it will have rotated off the visible disk entirely. The other 3 sunspots in the eastern hemisphere of the disk are all relatively simple with no appreciable flare risks.

A marked filament eruption was observed leaving the sun on 02 Sept. The CME that followed is modelled to have been passing mostly behind and below the Earth, though there is a chance of a glancing blow on 05 Sept (day 3). No other Earth-directed CMEs were observed.

Solar activity is expected to remain largely Low, with an ongoing chance Moderate flares at times, mostly from AR3089. However a bright flux region is visible on the EUVI/AIA 195 imagery, indicating the presence of an active region. This region may rotate onto the northeast limb on day 3 (05th), potentially increasing the probabilities of a significant flare.

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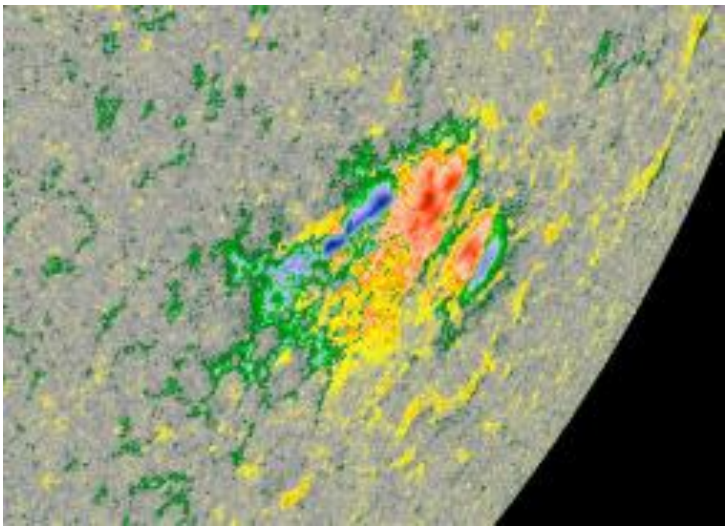
X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	35	35
Very Active	R3 to R5 X Class	No	3	3	3	3

Figure 3: HMIBC mangentogram imagery showing the size and magnetic complexity of AR3089.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) remains at background values. Despite and apparent stability, AR3089 (Eai/Beta-Gamma) continues to present a slight chance of a proton event at Earth, should there be any significant flaring. This risk will continue as the region rotates further across the southwestern quadrant.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	3	3	3	3
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy protons (greater than 10 MeV) are expected to remain below S1/Minor radiation storm levels. The high energy (greater than 2 MeV) electron flux is expected to be at background levels initially but to increase over the following days, with an increasing chance of exceeding high levels.

The corresponding 24 hour fluence is expected to display a sharp rising trend from 04 Sept (day 2) onward, with a chance of exceeding the Active threshold on 06 Sept (day 4) as wind speeds also begin to fall.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	10	30	50
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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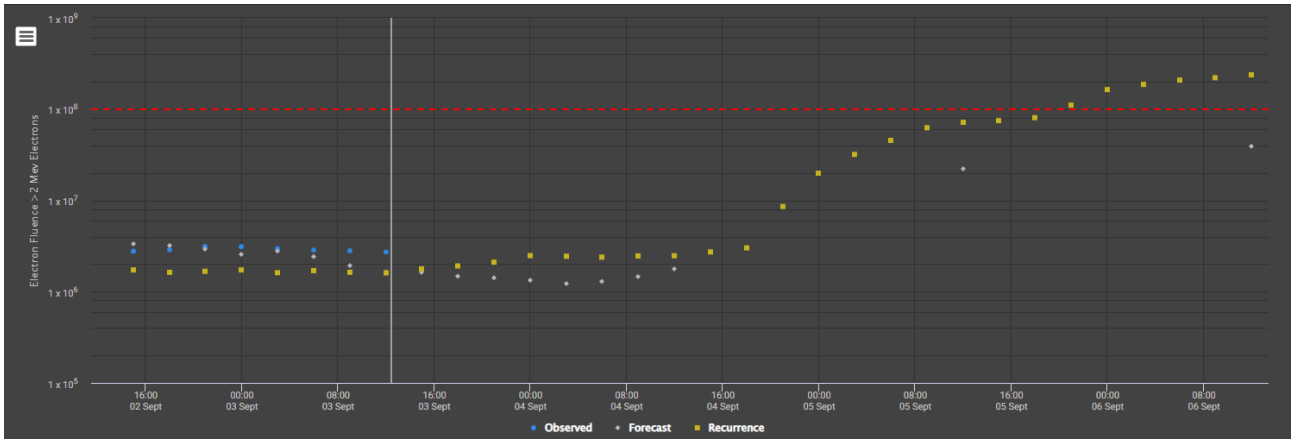
Figure 4: REFM showing observed, persistence and forecast electron fluence levels.



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